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Morphology and Growth Pattern of Amazon Deep-Sea Fan: A Computer-Processed GLORIA Side-Scan Sonar Mosaic

Deep-sea fans have become increasingly important targets for exploration because of their favorable facies associations. A better understanding of deep-sea fans is needed to successfully exploit these complex sediment bodies. Recent studies of the Amazon fan, using long-range side-scan sonar (GLORIA) and single-channel seismic data, provide an overall view of channel patterns on this fan and demonstrate the relationship between successive channel/levee systems. The digitally collected GLORIA data have been computer processed to produce a mosaic of the fan. Computer processing has corrected the records for slant range and ship navigation, and targets have been enhanced. Many features of the modern fan system are readily apparent on the sonar mosaic. The 1.5 to 0.5-km (5,000 to 1,600-ft) wide channels meander intensely across the fan with sinuosities up to 2.5. Because of these meanders, the channel gradients decrease regularly across the fan despite changes in regional slope. Other channel-related targets include cutoff meanders, overbank deposits (especially small debris flows), and channel branchings. Other debris flows cover large areas of the fan and override channel/levee systems. Air-gun records show that this fan is built of a series of channel/levee systems that overlay one another. Channels from at least 6 of these systems are visible at the surface now, but apparently only one channel at a time has been active. The length of time needed to build a single channel/levee system is not known, but it appears to be rapid.

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Upper Fort Union Coals in Western Powder River Basin, Wyoming: Alluvial-Plain Deposits

Stratigraphic distribution of coals and associated lithofacies in the upper Fort Union Formation (Paleocene) was investigated in outcrop and subsurface from southeast of Sussex to south of Buffalo, Wyoming. In this area, Ayers and Kaiser in 1982 proposed that upper Fort Union coals accumulated in deltas and interdeltas, and pinched out into a lake. Our study does not support these interpretations.

The upper 1,000 ft (300 m) of the Fort Union Formation in the western Powder River basin comprises interbedded conglomerates, conglomeratic sandstones, sandstones, siltstones, mudstones, carbonaceous shales, and coals. The conglomerates, consisting of pebbles and cobbles reworked from Mesozoic and Paleozoic rocks, are in scour-based bodies as thick as 25 ft (8 m). A 300-ft (90-m) thick, 12-mi (19-km) long conglomeratic channel-sandstone complex is in the lower part of the interval. In the upper part of the interval, conglomeratic single- and multistory channel sandstones reach thicknesses of 100 ft (30 m) and widths of 4,000 ft (1,200 m). These channel sandstones grade into overbank-floodplain sediments, which are interbedded with backswamp deposits of coals and carbonaceous shales. The conglomeratic channel sandstones are interbedded with coal beds as thick as 20 ft (6 m). These coal beds probably are laterally equivalent to the 178-ft (54-m) thick Sussex coal deposit to the east.

Lithofacies associated with the coals in the western Powder River basin suggest an alluvial-plain paleoenvironment. The alluvial plain consisted of braided and meandering streams flanked by well-drained and poorly drained backswamps. These streams probably are northeasterly flowing tributaries of trunk streams.

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Geothermal Resources of Balcones-Ouachita Trend, Central Texas

The Balcones-Ouachita trend of central Texas is an often overlooked zone with great potential for widespread occurrence of low-temperature geothermal resources. The area with potential resources extends from north of Dallas to Del Rio. Thermal input to these systems is from the natural thermal gradient of the earth. Downdip movement of ground water from recharge zones to the west, or updip flow from overpressured zones within the Gulf Coast basin, are 2 possible sources for fluids. Permeability in these systems is typically stratigraphic, but local enhancement by fractures and faults aids fluid flow. Basal Cretaceous sandstones, such as the Hosston Formation and its lateral equivalents, and Cretaceous limestones, such as the Edwards formation, have identified resources. Resource models developed to date indicate higher temperatures where updip flow from the basin is enhanced by fault permeability. Recent tests of these resources include a geothermal well in Marlin, where the Hosston Formation produces 67°C (153°F) fluids from a depth of 1,183 m (3,881 ft), and a program conducted in the fall of 1983 to assess the geothermal characteristics of the Hosston Formation in the San Antonio area. Results of this program are still being evaluated. In the San Antonio area, warm waters have been produced from the Edwards formation.

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Selection Parameters and Subsurface Explorations for Oil Mining Projects

Oil mining offers the potential for significant additional recovery of oil remaining in reservoirs after primary, secondary and tertiary production methods have been applied. Potential reserves for oil mining techniques within the United States is estimated to include 300 billion bbl of light oil and 200 billion bbl of heavy oil. Projects tested throughout the world have demonstrated the technical feasibility of oil mining. Recent evaluations indicate that this technology is economically competitive with most enhanced oil recovery (EOR) methods.

Oil mining can be divided into two general categories: surface mining and underground mining. Surface mining appears applicable to near-surface reservoirs with low overburden ratio and high oil saturation. Heavy oil and tar sands offer many potential targets for surface mining. Underground mining is applicable to reservoirs less than 3,000 ft (900 m) deep, using the mining-for-access method. Mining for access includes the development of underground space at the base of a reservoir and the drilling of closely spaced drainage wells upward into the reservoir. This mining method produces oil by gravity drainage and is therefore applicable to underpressured reservoirs with adequate oil mobility.

Selection and development of an oil mining project is based on a unique combination of mining engineering, geotechnical engineering, and petroleum engineering parameters and considerations. As with EOR projects, successful implementation of this technology depends on a detailed understanding of the subsurface conditions in the project area. Subsurface exploration programs for oil mining projects must be highly integrated in order to provide useful data for each of the applicable disciplines to perform their respective evaluation and design analyses.

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Late Pleistocene Ice-Proximal Glaciomarine Subaerial Delta and Submarine Outwash Fan Lithofacies, Fraser Lowland, British Columbia, Canada

Field study of sedimentary textures, structures, and lithofacies of upper Pleistocene sediment deposited when glaciers retreated from a fjord indicate local depositional history and environment. Three discrete lithofacies sequences are inferred to be ice-proximal deltaic and submarine outwash-fan deposits of a glaciomarine environment.

Two delta-plain sequences are composed of planar-stratified and large-scale trough-cross-bedded sands and clast-supported gravels. Delta-front facies comprise interstratified sands, silty sands, and pebbly sands that contain ripple and climbing-ripple cross-stratification. Mud drapes on ripples indicate that traction currents were episodic but frequent. Nonrippled sands are reverse to normally graded or normally graded low-density gravity-flow deposits or discontinuous underflow deposits. Structureless sands resulted from grain flow or settled from a turbid overflow plume. Prodeltaic facies dominated by muds are rhythmically interstratified with sand and are deposited from turbid overflow plumes. Other coarser-grained sands are turbidites associated with slumps, slide blocks, and debris-flow deposits shed off the delta front.

The submarine outwash-fan sequence comprises scour channels infilled by matrix-supported gravel overlain by mass-flow deposits of planar-interstratified sand and mud. Channel infills are overlain by stratified matrix-supported gravels and sands and structureless clast-supported gravels deposited by debris flows which deformed underlying sands. Inasmuch as submarine outwash-fan sequences characteristically contain matrix-supported gravels, planar-interstratified sand and mud infill of channels and lack large-scale trough cross-bedding, they can be distinguished from deltaic sequences.

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Relationships Among Carbon Dioxide, Pore-Fluid Chemistry, and Secondary Porosity, Texas Gulf Coast

Sequences of diagenetic minerals associated with secondary porosity show striking similarities. The formation of quartz overgrowths on detrital quartz grains is followed generally by carbonate cementation. The dissolution of this carbonate is the main secondary porosity-forming event, which commonly precedes kaolinite precipitation and iron-rich carbonate cementation. In the Texas Gulf Coast, oxygen isotopic analyses provide temperature estimates of authigenic phases that predate and postdate secondary porosity development: quartz, $\geq$ 80°C (176°F); kaolinite, $\geq$ 70°C (158°F); albite, 100°-150°C (212°-302°F); late carbonate, > 100°C (212°F). These data suggest that secondary porosity in the Tertiary Gulf Coast forms at temperatures of about 100° ± 25°C (212° ± 45°F).

Correlations among calcite saturation indices in pore fluids, abnormally high permeabilities, and mole % CO_2 in natural gases of the Eocene Wilcox Group imply a strong interrelationship between CO_2 and secondary porosity development in clastic reservoirs. The CO_2 content of gases varies systematically with both the reservoir age and temperature, which suggests a kinetic control on generation. The amount of CO_2 in natural gases increases rapidly at approximately 100°C (212°F); this coincides with a rapid increase in the ratio of secondary to primary porosity in associated sandstones. Stable isotopic analyses of carbonate cements indicate a strong component of organically derived carbon and therefore cycling of carbon between inorganic and organic systems. The type, amount and distribution of organic matter, and early carbonate in both shales and sandstones control the quantity of CO_2 available for generating secondary porosity.

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Complete Dehydration of Illite/Smectite in Gulf Coast Overpressured Shales

Twelve samples of Frio and Vicksburg (Tertiary) overpressured shales from Brazoria and Hidalgo Counties, Texas, were examined by both x-ray and transmission electron microscopy (TEM) techniques. TEM lattice fringes from shallower samples show mixed-phase illite/smectite (I/S) layers in random orientations relative to each other. Electron diffraction patterns of these shallower I/S layers show very diffuse basal reflections together with very pronounced turbostratic structure and streaking along z*. Electron diffraction patterns of I/S layers from intermediate depths still show z* streaking and turbostratic structure, but the basal reflections are more distinct. TEM lattice fringe images of intermediate depth samples show I/S layers arranged in a subparallel orientation. Electron diffraction patterns of I/S layers from deeper samples generally show well-defined basal reflections, and both turbostratic structure and z* streaking are less pronounced. An electron diffraction pattern of I/S layers from one deep sample (12,490 ft, 3,800 m, calculated equilibrium temperature of 168°C, 334°F, and pore-pressure gradient > 0.7 psi/ft, 15.8 kPa/m) shows an illite $2M_1$ pattern, indicating complete dehydration of original I/S layers. The presence of pronounced z* streaking is thought to be due to disordered stacking of layers, which in turn is caused by diagenesis of original mixed-phase I/S layers. TEM lattice fringe images for this sample show parallel illite layers with basal spacing of approximately 20 A.

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U. S. Geological Survey Oil and Gas Atlas of the United States

The U. S. Geological Survey is compiling a series of oil and gas maps that the Survey will publish as an oil and gas atlas of the United States. The maps in the series will synthesize information both on the national scale and for individual basins, and will include geologic, geochemical, geophysical, and exploratory data.

The maps displayed are the preliminary publications (open-file reports) of this new series. The national-scale maps for the conterminous United States show (1) location and names of basins, (2) total thickness of sedimentary rocks, (3) location of oil and gas wells drilled deeper than 15,000 ft (4,500 m), and (4) location of oil and gas wells drilled deeper than 20,000 ft (6,000 m). Basin maps of the north slope of Alaska show (1) well locations, (2) isopachs, and (3) structure contours.

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Reservoir Facies Architecture in a Micro-Tidal Barrier System, Frio Formation, Texas Gulf Coast

Barrier-bar sand bodies are a complex mosaic of barrier-core, shoreface, inlet-fill, tidal-delta, and back-barrier facies. In addition, sand-body stratigraphy and internal depositional architecture are determined by the progradational, aggradational, or transgressive origin of the barrier complex.

The Frio barrier/strandplain system of the middle Texas Gulf Coast has produced more than 3 billion bbl of oil. Examination of the Greta, Glasscock, and 41-A sands in West Ranch field illustrates the variability of barrier reservoirs. Each reservoir is a mosaic of variably interconnected compartments having sheet, tab, pod, or channel geometries. Conventional facies analysis (isolith and log-pattern mapping and limited core examination) combined with semiquantitative delineation of hydrocarbon-saturation distribution using resistivity logs defined the facies components of each reservoir. The 41-A sand consists of juxtaposed progradational barrier-core, inlet-fill, and flood tidal-delta units. The Glasscock sand is largely a transgressive barrier-flat and washover-fan deposit. The Greta sand is a complex of aggradational barrier-core and inlet-fill facies.

Productive attributes of each reservoir are influenced by its facies architecture and attendant relative permeabilities. Natural water drive is ineffective in the volumetrically restricted transgressive Glasscock reservoir. Permeability distribution in the 41-A reservoir is facies defined. Erratic injection response, irregular oil-water contact advance, and variable water/oil ratios observed during the productive history of individual reservoirs document localized facies effects on fluid flow. Spatial variation of the gas/oil ratio may also reflect facies distribution.

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Potassium-40/Argon-40 Age Determinations on Low-Potassium Glauconites Near Missing Cretaceous-Tertiary Transition at Littig Pit, Travis County, Texas

Potassium-40/Argon-40 dating on glauconites from Littig Pit, Travis Co., Texas, indicates that 4 to 6 Ma of lowermost Tertiary section are missing. The glauconite-containing samples were examined biostratigraphically. At least 1 calcareous nannofossil zone and at least 2 planktonic foraminiferal zones missing from the lowermost Tertiary limit the missing section to 2.5 to 5 Ma. These paleontologic data are fully consistent with the radiometric dates obtained on low potassium glauconites and refute the view of Odin that all low potassium glauconites are suspect. A missing nannofossil zone in the uppermost Cretaceous represents an undetermined amount of time.

A strong probability exists that the Midway Group at Littig Pit and elsewhere was deposited rapidly during one of the earliest Paleocene transgressions described by Vail and others, and our data support the conclusion of Berggren and Aubert that the Midway fauna are correlatable worldwide. The iridium layer of Alvarez and others is missing at the Littig